

charge, and if consequently we must look to some other, possibly accidental, cause for Rowland's observation, it will certainly revolutionise the whole modern treatment of electro-magnetism. The question raised by this experiment is, any way, one of the most fundamental ones in the connection between ether and matter, and it is to be hoped that this question will be settled soon in a conclusive way, either by showing that M. Cremieu's conclusion is not justified by his observation that his experiment really confirms a complete theory, or by overthrowing all our existing views, and leaving a free field for the twentieth century to build a new theory of electro-magnetism on a firmer foundation.

In discussing the result of Michelson and Morley's experiments, from which they concluded that the ether is carried along by the earth in its motion, Mr. Larmor shows that such a hypothesis is quite inconsistent with the fact of aberration and with the untenability of Sir George Stokes's suggestion that ether is like a very soft jelly. How such a soft material could be the means by which tramcars are driven by shearing stresses seems an additional difficulty in the way of this suggestion. Mr. Larmor concludes that the stone support on which the mirrors were borne changed in its dimensions, as it was rotated, by an amount proportional to the square of the ratio of its velocity to the velocity of light, and he justifies this by showing that if matter consists of clusters of electrons, just such a change of dimensions would take place as the experiment shows to take place. There is some difficulty in the hypothesis that the inertia of matter, or any large part of it, is like that of electrons and due to the motion of the neighbouring ether, because this involves the supposition that the inertia would change with the distance between the component electrons. That there may be some very minute effect of this kind is quite possible, though as yet undiscovered, but that any large effect of the kind exists seems extremely improbable. Possibly a careful study of the accuracy of Kepler's laws as applied to the solar system might show some discrepancy depending on a difference between the average distance of the electrons in such different materials as probably constitute Neptune and Mercury.

A previous question to all our explanations of phenomena by analytical dynamics is raised by Mr. Larmor in Appendix B, "On the Scope of Mechanical Explanation: and on the Idea of Force." He has utilised the principle of least action throughout his work, and this appendix is a justification of his doing so, and besides raises questions as to the applicability of dynamical explanation to the growth and decay of vital organisms. Hertz objected to the adequacy of the principle of least action as a complete solution of all possible dynamical systems, because it is not generally applicable when rolling takes place, and we cannot be sure that rolling may not be one of the fundamental facts of the dynamics of the ether. Mr. Larmor dismisses this objection on the doubtful ground that "rolling is foreign to molecular dynamics." Hertz had also objected to the principle of least action for the semi-metaphysical reason that it makes the present state of the system depend on the future as well as on the past. As Mr. Larmor himself uses in his work the vector potential which makes the state at each place

depend on what is simultaneously occurring at all parts of the universe, he naturally finds no objection to the principle of least action, because it makes the present depend on all future time. Neither of these methods is unobjectionable; each is an analytical juggle, which has to be most carefully guarded lest it lead us into mistakes. The way in which the vector potential apparently locates the energy in the current instead of in the magnetic field outside it is a most serious objection to its use, although Mr. Larmor seems to have steered clear of the difficulties raised by this curious complication. In a similar way the principle of least action is open to the objection of Hertz of making the present apparently depend on the future to an extent that does not apply to his own principle of the straightest path. It is a question for consideration in connection with Mr. Larmor's discussion on the applicability of dynamics to vital phenomena whether the possibility of determining our actions by considerations as to the future is not connected with the possibility of analytically expressing the dynamics of the present by a formula which involves the future.

It will, from this meagre review, be evident that Mr. Larmor's treatise raises most fundamental and interesting questions, and is one that all who desire to strengthen the foundations of our knowledge of nature should carefully study.

GEO. FRAS. FITZGERALD.

LAND RECLAMATION.

The Reclamation of Land from Tidal Waters. By Alexander Beazeley, M.Inst.C.E. Pp. xii + 314. (London: Crosby Lockwood and Son, 1900)

THE area of this country is gradually diminishing by the continual waste that is going on all round the coast. On the Yorkshire coast it is estimated that two miles have disappeared since the Roman occupation; and more modern records show that towns and villages have disappeared with their houses and churches, and in some cases the whole parish has been washed away. Along the Norfolk coast the only record of several villages is, "washed away by the sea"; and on the Kentish coast, churches and houses have fallen down the cliffs, on which are to be seen the bones formerly deposited in a vanishing churchyard. On the south coast, although the chalk cliffs at the east end of the English Channel are subject to continual falls and slips, more care has been taken to protect them; but along the clay cliffs of Dorsetshire the waste is continuous; here twenty acres slipped down seaward in one night from the cliffs at Axminster. On the west coast, the nets of the fishermen are said to become occasionally entangled with the ruins of houses and buildings buried in the sea some distance from the coast off Blackpool.

As some compensation for all this loss due to the ever-continuous operations of nature, the energy of man has succeeded in reclaiming and recovering a large area of rich cultivatable land in estuaries where rivers have discharged great quantities of detritus picked up along their course. At no time in the history of this country were reclamations carried on to a greater extent than in the time of the Romans, and this is the more remarkable as, compared with the population at that time, land must have been plentiful. It was during

this era that the great tract of low land lying on the east of England was reclaimed from the sea by the construction of 50 miles of sea-banks, and the 60,000 acres in the district known as Romney Marsh was protected from the sea by a bank 4 miles long and 20 feet high. From the time of the Romans to the Stuart period very little seems to have been attempted in this way, but at that time there are records of innumerable grants made to "undertakers" and "adventurers" who undertook to reclaim the low lands in the Isle of Axholme, Haxey Chase and the Fens of Lincolnshire and Cambridgeshire, and other parts of the country, in return for a certain proportion of the land reclaimed. Another revival took place during the present century at the time when agriculture was prosperous, and land-owners were tempted, by the high rents then paid, to reclaim from the sea numerous intakes of salt marshes by the construction of sea banks in the estuaries of the Humber, the Wash, the Thames, the Severn and other rivers. Since rents have fallen and land-owners have become impoverished by the low rents, and the heavy charges thrown on estates by the payment of the death duties, little or no inclosing has taken place. Land, however, shows signs of recovering something of its former value. The appearance, therefore, of a book dealing with the reclamation of land from tidal waters may be considered as opportune.

The only standard English book on this subject is that of the late Mr. John Wiggins on the "Practice of Embanking Lands from the Sea," which is now out of print. Instead of publishing a new edition with the extensive alterations of the text that would be required to bring this work up to date, the author of the book now under review was invited by the publishers to undertake the preparation of a new treatise, in which all that was applicable to modern practice in Mr. Wiggins' book has been incorporated.

The author has carried out his task efficiently and well, and his book contains a large amount of information that will be of great service to engineers, and also to landed proprietors and others interested in works of reclamation.

The book makes no pretensions to originality; on the contrary, it may be regarded as an epitome of the information and opinions contained in a vast number of papers contained in the *Minutes of Proceedings* of the Institution of Civil Engineers and the papers of allied societies, and in the works of authors on drainage and Fen history.

A careful perusal of a book of this character, and the principles laid down that should be observed in the reclamation of land, might have saved the expenditure of many thousands of pounds on schemes that never came to maturity or have proved financially disastrous. Of these, as examples, may be quoted the great scheme that was at one time entertained, and still has advocates, for the formation of a new county in the Wash, by the enclosure of the sands; an offshoot of which was the abortive scheme of Sir John Rennie for reclaiming 30,000 acres, the greater part of which was bare sands, which experience has since proved would have been utterly unfit for cultivation; and the Norfolk Estuary Scheme, which received parliamentary sanction in 1846 to reclaim

30,000 acres submerged at high water, and of which up to the present time, after an expenditure of nearly 400,000*l.*, there has only been reclaimed 2000 acres of marsh land adjacent to the coast, a great part of which formed the bed of the diverted river. In this case, great benefit has resulted to the drainage of the country by a new direct cut made for the outfall of the river Ouse; but as a land reclamation scheme, it has been a most disastrous failure, owing to the misconception of the promoters as to the action of the sea in forming deposit on the coast, and of the difficulties attending the construction of sea banks.

Mr. Beazeley's book is divided into nine chapters, dealing respectively with: (1) General observations; (2) the site for a bank; (3) the construction of sea banks; (4) the drainage of the land reclaimed; (5) maintenance and repair of sea banks; (6) warping land; (7) cultivation after enclosure; (8) examples of reclamation, value and rents; (9) legal requirements; the text being accompanied by numerous illustrations.

THE MAMMALIAN BRAIN.

Handbuch der Anatomie und vergleichenden Anatomie des Centralnervensystems der Säugetiere. Von Dr. Edw. Flatau und Dr. L. Jacobsohn. I. Makroskopischer Teil, mit 126 Abbildungen im Text, und 22 Abbildungen auf 7 Tafeln. Pp. xvi + 578. (Berlin: Verlag von S. Karger, 1899.)

THE handsome volume before us is a welcome addition to works on the comparative anatomy of the mammalian brain. That the literature of this subject is already vast, may be gathered from the fact that nearly 300 papers are quoted at the end of the volume—this list forming indeed a most useful bibliography. So numerous and scattered are these various works, that only those students who have access to very complete libraries can hope to be able to consult the majority of them, and we have long felt the want of a trustworthy account of the structure of the brains of the various orders of mammalia in a more handy form. This want is to a great extent satisfied by the work of Drs. Flatau and Jacobsohn, which is rather of the nature of an original contribution than of a text-book. For it is no mere compilation; but, on the contrary, almost entirely consists of the description of brains studied by the authors themselves in Prof. Waldeyer's Anatomical Institute in Berlin.

With admirable care the authors describe the structure of the central nervous system of representative examples of all the living orders of mammalia. To give the reader some idea of the thoroughness of their method, one may mention that in the case of the brain of the Chimpanzee, for example, we find paragraphs on the brain weight, the relation of the brain to the skull, the general shape and measurements of the brain, followed by detailed accounts of the convolutions of the cerebral hemispheres, the structure of the corpus callosum, fornix, &c., of the Diencephalon, Mesencephalon, Metencephalon, Myelencephalon, and Medulla spinalis. Naturally the types of all the orders are not treated in quite as much detail as the Chimpanzee. At the end of the chapter on monkeys and apes are elaborate tabular statements of the authors' observations compared with those of previous writers on the subject. Throughout, the text is illustrated by excellent figures, almost all of which are original. The general